

# **Multiscale constitutive modeling of geomaterials - Applications to soil failure**

François NICOT  
Directeur de Recherche / Research Professor

IRSTEA - Grenoble  
Geomechanics Group  
Unité de Recherche Erosion Torrentielle Neige et Avalanches  
Domaine Universitaire, BP 76  
F38402 - Saint Martin d'Hères Cedex - France

Abstract:

Solving boundary value problems requires implementation of sufficiently robust constitutive models. Most models try to incorporate a great deal of phenomenological ingredients, but this refining often leads to overcomplicated formulations, requiring a large number of parameters to be identified. On the other hand, geomaterials are known to have an internal microstructure, made up of an assembly of interacting particles. Most of the macroscopic properties, observed on a specimen scale or even on larger scales, mainly result from the microstructural arrangement of grains. Thus, a powerful alternative can be found with micromechanical models, where the medium is described as a distribution of elementary sets of grains. The emergent complexity is not related to the constitutive description, but to the basic topological properties taking place on the microscopic scale. This presentation discusses this issue, showcasing very recent results obtained from discrete element simulations. Then, an advanced micromechanical model (3D-H model) is presented. It introduces an intermediate scale (mesoscopic scale) made up of a set of adjoining particles. This new approach makes it possible to recover many constitutive properties observed on

the macroscopic scale in a very natural way, such as the occurrence of diffuse versus localized failure modes. Some recent numerical results obtained from FEM computations are presented in order to give clear insights into the capability of such multiscale approaches to deal with engineering scales in the future.